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⑫ **EUROPEAN PATENT APPLICATION**

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㊴ **Method of aligning a radio receiver and means for indicating the alignment of a radio receiver.**

㊵ A radio receiver (10) having a tuned IF stage (20) which is followed by a detector stage (24) producing an output representative of the change in frequency of a signal applied at its input. A predetermined frequency alignment signal (80) and a white noise source signal are alternately switched through the IF amplifier stage (20) of the receiver being aligned. A series connected integrating capacitor (50) and a tuning meter (60) are coupled between the receiver's detector output (24b) and ground potential (70).

In operation, during the interval of white noise being applied to the IF stage, the tuning meter (60) is shorted (40, 44, 46) and the capacitor (50) is charged to a net voltage $V_n$ which is representative of the center frequency of the IF. When the alignment signal is applied to the IF stage, the tuning meter (60) short is removed and a signal $V_a$ appears across the capacitor-meter circuit, whereby the meter reading is indicative of $V_a$−$V_n$ which represents relative receiver alignment.
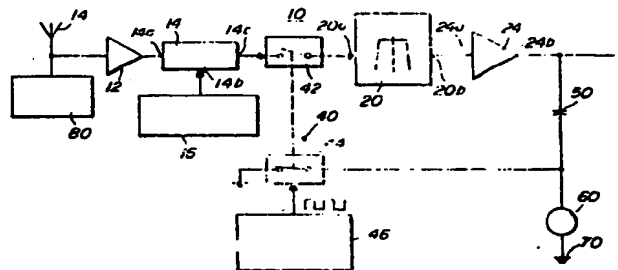
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# TITLE MODIFIED
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RADIO RECEIVER ALIGNMENT INDICATOR

Background of the Invention

The present invention pertains to the radio receiver
art and, more particularly, to a means for, and a method of
5      aligning a radio receiver.

The radio receiver art has developed several techniques
for the aligning of radio receivers. Alignment is a process
whereby various stages of the receiver are properly tuned to
the desired frequency. For example, when a signal of pre-
10     determined frequency is applied to the radio frequency input
stage of a receiver, the local oscillator stage, tuned
intermediate frequency stage, and detector stage must all be
adjusted to maximally reproduce the signal at the detector
output.

15     A typical alignment procedure known in the prior art is
as follows. A predetermined frequency signal is applied at
the radio frequency input, or antenna connection, of the
receiver being aligned. The local oscillator is adjusted
such that the output from the mixer is the input signal
20     converted to the receivers intermediate frequency which, in
a common FM radio is 10.7 MHz. The intermediate frequency
stage is then adjusted such that the alignment signal is
directly in the center of its passband. For receivers
employing a fixed tuned IF state, however, the receiver may
25     be misaligned due to the center band of the filter being at
other than the divided frequency. This results in misalign-
ment. Finally, a DC tuning meter is connected to the output

from the detector stage and the detector is adjusted such that the output reading is zero volts DC. Also, due to component value drifts caused by aging and thermal effects, a reading of zero volts DC may, in fact, correspond to a misaligned receiver.

The above described prior art alignment procedure suffers from numerous disadvantages. Firstly, it is a complicated and tedious procedure, not generally suited to efficient manufacturing operation. Also, for receivers employing fixed intermediate frequency tuned stages, the above procedure does not provide optimum alignment. In addition, it is desirable for purposes such as field alignment to use a zero centered DC tuning meter. For radio designs utilizing a quadrature detector, an output non-zero DC signal appears at the detector when the detector is properly aligned. This fact precludes the use of zero centered DC tuning indicators when used in the prior art aligning procedure.

## Summary of the Invention

It is an object of this invention, therefore, to provide a simple, efficient and precise method for the aligning of a radio receiver.

It is a further object of the invention to provide an improved means for indicating the relative degree of receiver alignment.

Briefly, according to the invention, a radio frequency receiver having a tuned intermediate frequency stage (IF) followed by a detector stage may be aligned by first alternately applying a noise signal and then a predetermined frequency signal to the IF stage. The receiver is then adjusted such that the output of the detector stage responsive to the applied noise signal bears a predetermined relationship to the detector stage output responsive to the applied predetermined frequency signal. Preferably, the

frequency of the receiver's local oscillator is adjusted
until the voltage at the detector output is the same whether
the noise signal or the predetermined frequency signal is
applied.

5          The means for indicating receiver alignment includes a
signal generator for generating a predetermined frequency
alignment signal, a noise source for generating a random
noise signal and a switching means which alternately couples
the predetermined frequency alignment signal and the noise
10         signal to the receiver's intermediate frequency stage. A
comparator compares the output of the detector stage respon-
sive to the predetermined frequency alignment signal being
coupled to the IF stage with the output of the detector
responsive to the noise signal being applied to the IF
15         stage. An error signal is produced indicative of the tuning
of the receiver stage with respect to the predetermined fre-
quency alignment signal. Preferably, the comparator com-
prises a capacitor which has one terminal coupled to the
output of the detector and the other terminal coupled
20         through a meter to reference, or ground potential. The
switching means further includes a means which short cir-
cuits the meter during the time that one of the predeter-
mined frequency alignment signal and noise signal is applied
to the IF stage. In this manner, the fluctuation of the
25         meter is indicative of the difference between the magnitudes
of the detector stage outputs corresponding to the predeter-
mined frequency alignment signal and the noise signal being
coupled to the IF stage and, thus, is indicative of the
relative alignment of the radio receiver.


30    Brief Description of the Drawings


          Fig. 1 is a block diagram illustrating the basic
structure and operation of the preferred embodiment of the
invention; and
          Fig. 2 shows a series of waveforms representative of
35    operation of the preferred embodiment shown in Fig. 1.

## Detailed Description of the Preferred Embodiment of the Invention

Fig. 1 illustrates, in block diagram form, a conventional radio receiver, indicated generally at 10 in combination with the preferred embodiment of the alignment
5     indicator. The receiver is comprised of a conventional RF input stage 12 adapted for receiving signals over an antenna 14. The output from the RF stage 12 feeds to the first input 14a of a conventional mixer circuit 14. Applied to
10    the second input 14b of mixer stage 14 is the output from the local oscillator stage 16. Local oscillator stage 16 is of conventional design, and is tunable over a defined range suitable for converting the signal received at the mixer first input 14a to the intermediate frequency of the
15    receiver.

The converted output appearing at the mixer output 14c is coupled to the input 20a of a conventional tuned intermediate frequency stage (IF) 20. Intermediate frequency stage 20 is of standard design employing circuits having
20    tuned characteristics about a center frequency $f_c$. In a typical FM radio receiver, $f_c$ is selected to be 10.7 MHz. The amplified and filtered signal from IF stage 20 appears at the stages output 20b and passes to the input 24a of a conventional detector stage 24. Acting in the known manner,
25    the detector 24 which produces an output signal representative of the frequency change of signals applied to it, recovers the information, e.g. audio signal, contained in the input RF signal, reproducing this information signal at its output termnal 24b.

30    The alignment indicating circuitry, according to the preferred embodiment of the invention, includes switching means, indicated generally at 40, which includes a first switch 42, coupled between the mixer output 14c and the IF input 20a, a second switch 44 and a switching control oscil-
35    lator 46. Each switch 42, 44 is of the single pole/single throw type and responds to control signals generated by

switching control oscillator 46 to appropriately either
short, or open its contacts. Thus, the switches 42, 44 may
be comprised of relays or, preferably, suitable semicon-
ductor devices such as bipolar transistors. In this, the
5 preferred embodiment of the invention, the two switches 42,
44 are connected 180° out of phase, such that when one
switch is open, the other is closed.

A series connected integrating capacitor 50 and tuning
meter 60 are coupled between the detector output 24b and
10 reference, or ground potential 70. As will be understood
more fully hereinbelow, capacitor 50 is of selected value to
integrate the signals alternately applied to it as a result
of the switching means 40.

Tuning meter 60 is of conventional design, reading
15 center scale with zero volts DC applied to it. In this, the
preferred embodiment of the invention, tuning meter 60 is
selected to be deflected full scale, in either direction,
with an applied current of 25 microamps.

The method of aligning a radio receiver according to
20 the instant invention, and operation of the means for
indicating receiver alignment, may be understood as follows.
A signal source 80 is coupled to the input of the RF stage
12. The signal source 80 is adjusted to generate a pre-
determined frequency alignment carrier. The alignment
25 carrier signal is converted, via the operation of mixer 14
and local oscillator 16, to the intermediate frequency
whereby the converted signal appears at the mixer output
14c. In its first mode of operation, that is when its con-
tacts are shorted together, switch 42 couples the converted
30 alignment signal through the IF stage 20 and detector stage
24 whereby the output from the detector responsive to the
applied alignment signal appears at the detector output 24b.
When switch 42 is in its second mode of operation, i.e. its
contacts being open circuited, a random, white noise signal
35 appears at the input 20a of the IF stage 20. It is commonly
known to one of ordinary skill in the art that the input 20a

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by adjusting local oscillator 16 such that the reading on meter 60 is a zero volts DC.

Fig. 2 illustrates representative waveforms appearing at the output 24b of detector 24 during operation of the

5   alignment method. Here, the time $t_1$ is representative of the time during which the first switch 42 is in its second mode of operation (6 milliseconds in the preferred embodiment of the invention) with the time $t_2$ representative of switch 42 being in its first mode of operation (2 milli-

10  seconds in the preferred embodiment of the invention). Thus, referring to Fig. 2a, which is representative of the alignment frequency signal being at a frequency below the center of the IF 20 passband, during the time $t_1$ capacitor 50 is charged to the voltage $V_s$. Then, during time

15  interval $t_2$, white noise is fed through IF 20 and the meter circuit 60 is shorted. This produces a noise voltage, which is centered about $V_n$. The difference between the two signals $V_s - V_n$ is a net negative voltage which drives meter 60 of Fig. 1 in the negative direction.

20  In Fig. 2b, the alignment signal is at a frequency above the center passband of IF 20 and detector 24. Here, the net error signal $V_s - V_n$ is positive, which drives meter 60 to a positive reading.

By adjusting the duty cycle of time periods $t_1$ and

25  $t_2$ the reading of meter 60 may be calibrated in terms of frequency of misalignment, in hertz per unit of voltage error.

In addition, by proper selection of the capacitor 50, the sampling rate, the duty cycle and the mechanical damper-

30  ing of the meter 60, the meter assumes as table reading indicative of receiver alignment.

In summary, the method of aligning a radio receiver, according to the instant invention, may be efficiently performed while maintaining a high degree of precision.

35  The means for indicating the degree of receiver mis-alignment, according to the invention is precise, and

inexpensive to implement. Further, for receivers employing detectors which inherently have a DC offset at the output 24b, such as quadrature detectors, the instant indicator means allows a zero center DC meter to be employed due to

5 the DC blocking action of capacitor 50.

While a preferred embodiment of the invention has been described in detail, it should be apparent that many modifications and variations thereto are possible, all of which fall within the true spirit and scope of the invention.

10 For example, whereas in the instant embodiment of the invention an alignment signal was converted through the mixer before being applied to the IF stage, it should be apparent that an alignment signal could be applied directly to the IF input and the receiver aligned accordingly.

15 We claim:

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Claims

1. The method of aligning a radio receiver (10) having a tuned intermediate frequency stage (IF) (20) followed by a detector stage (24), which detector stage produces an output representative of the change in frequency of a signal applied at its input,

a) alternately applying a noise signal and a predetermined frequency alignment signal (80) to said IF stage; and

b) aligning said receiver such that the output of said detector stage (24b) responsive to the applied noise signal bears a predetermined relationship to said detector stage output (24b) responsive to the applied predetermined frequency alignment signal.

2. The method of claim 1 wherein said radio receiver
(10) has a mixer stage (14) feeding said IF stage (20) said
mixer stage having a signal input (14a) for receiving said
predetermined frequency alignment signal and a local oscil-
lator input (14b) for receiving a local oscillator signal
(16), said local oscillator signal (16) being tunable over a
predetermined frequency range to convert signals received at
said mixer signal input to the frequency of said IF stage;
and wherein step a) further comprises the steps of:
1) providing a first switch means (42) which
responds to a received control signal to couple the con-
verted output of said mixer (14) to said IF stage (20) in a
first mode and to couple white noise to the input of said IF
stage in a second mode; and
2) providing a controlling oscillator means (46) to
predeterminedly activate said first switch means (42)
between its first and second modes.

3. The method of claim 2 wherein step b) further com-
prises:
1) comparing the detector stage output (24b)
responsive to said first switch means (42) being in its
first mode to the detector stage output (24b) responsive to
said first switch means being in its second mode; and
2) varying the tuning of said local oscillator (16)
to establish a predetermined relationship between said com-
pared outputs.

4. The method of claim 3 wherein step b) 1) further
comprises:
i) providing a predetermined value capacitor (50);
ii) coupling one terminal of said capacitor to the
output of said detector stage (24b);
iii) providing a meter means (60);
iv) coupling said meter means between the free end
of said capacitor and reference potential (70); and

v) providing a second switch means (44), responsive to said controlling oscillator (46), to apply a short circuit across said meter (60) in response to said first switch means (42) being in its second mode,

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whereby the signal measured by said meter (60) is indicative of the relative alignment of said radio receiver (10).

5. Indicator means for indicating the relative align-
ment of a radio receiver (10), having a tuned intermediate
frequency (IF) stage (20) followed by a detector stage (24),
which detector stage produces an output (24b) representative
5    of the change in frequency of a signal applied at its input
(24a), comprising:

        signal generator means (80) for generating a pre-
determined frequency alignment signal and a noise source
means for generating a random noise signal;

10        switching means (42) for alternately coupling, at a
predetermined rate, the predetermined frequency alignment
signal (80) and the noise signal to said IF stage; and

        comparator means (50) for comparing the output of
said detector stage (24b) responsive to the predetermined
15    frequency alignment signal being coupled to the IF stage
with the output of said detector stage (24b) responsive to
the noise signal being applied to said IF stage and pro-
ducing an error signal (60) indicative of the tuning of said
IF stage with respect to said predetermined frequency align-
20    ment signal.

6. The indicator means of claim 5 wherein the comparator means comprises:

      capacitor means (50), of predetermined value, having one terminal coupled to the output of said detector
5     (24b);

      meter means (60), for indicating the magnitude of said error signal, coupled between the free end of said capacitor and a reference potential; and

      wherein said switching means further comprises:
10     means for short circuiting (44) said meter means (60) during the time that one of said predetermined frequency alignment signal and noise signal is coupled to said IF stage,

      whereby the deflection of said meter is indicative
15     of the difference between the magnitudes of the detector stage outputs corresponding to the predetermined frequency alignment signal and the noise signal being coupled to said IF stage.
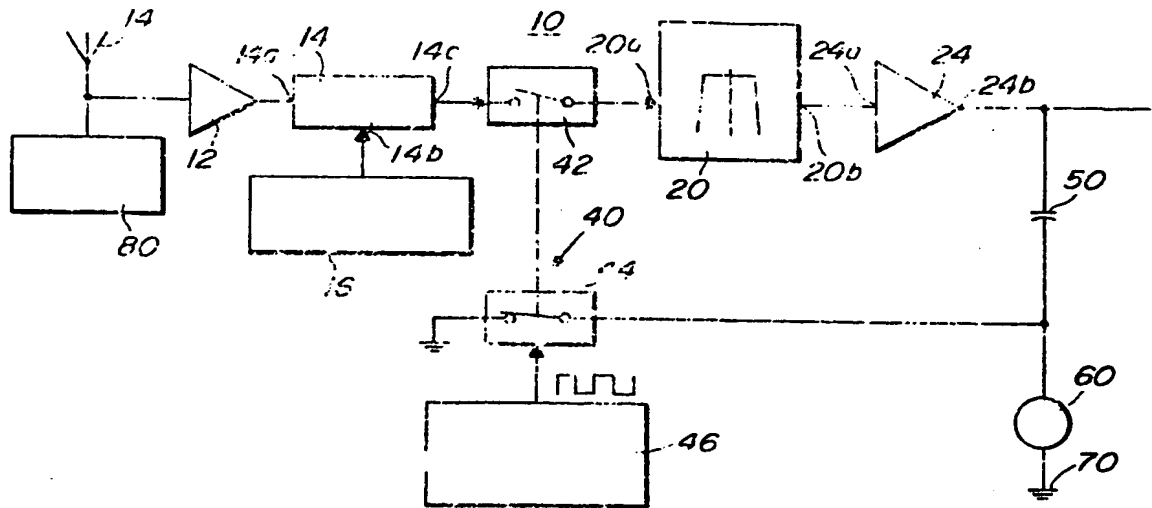
FIG.1

FIG.2A
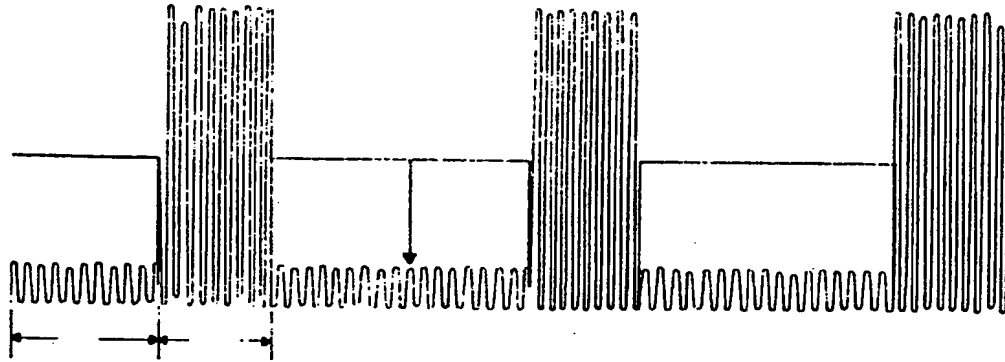


FIG.2B
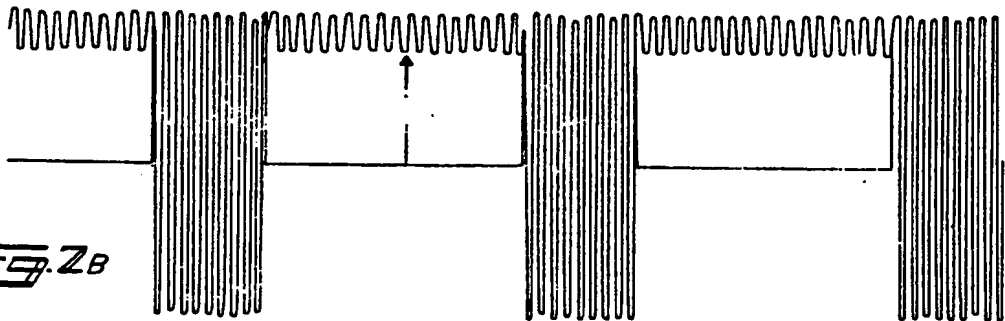
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**EUROPEAN SEARCH REPORT**

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Application number

EP 79 30 0029

| DOCUMENTS CONSIDERED TO BE RELEVANT | | | CLASSIFICATION OF THE APPLICATION (Int. Cl.³) |
|---|---|---|---|
| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | |
| A | <u>DE – B – 1 034 716</u> (PATELHOLD)<br>＊ Column 3, line 3 – column 4, line 14; figures ＊<br><br>-- | 1 | H 03 J 3/14<br>H 04 B 1/20 |
| A | <u>US – A – 3 896 386</u> (OHSAWA)<br>＊ Column 3, line 10 – column 4, line 7; figure 2 ＊<br><br>-- | 1 | |
| A | <u>GB – A – 559 555</u> (PHILCO)<br>＊ Page 3, lines 33–114; figure 1 ＊<br><br>-- | 1 | TECHNICAL FIELDS SEARCHED (Int.Cl.³)<br><br>H 03 J 3/14<br>　　　　3/12<br>H 04 B 1/26 |
| A | <u>DE – A – 2 624 787</u> (ONKYO)<br>＊ Page 18; figure 10 ＊<br><br>---- | 1 | |

CATEGORY OF CITED DOCUMENTS

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L: citation for other reasons

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The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| The Hague | 20-04-1979 | THOMAS |